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ON THE FEASIBILITY OF RAINWATER HARVESTING - A CASE STUDY IN AN EDUCATIONAL INSTITUTE, NEARBY THE WESTERN GHATS

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ABSTRACT

Aim of this communication is to quantify the availability of rooftop water within the campus. It also inquires the possibility of catering the existing water demand. Furthermore, beside the existing water usage pattern, an independent water use or demand for uniform availability of rooftop water is calculated. Capacity of storage structures, at least for the monsoon months is estimated for the peak discharge. It is imperative to store all whopping amount of the rainfall which leads to go for the subsurface recharge methods.

KEYWORDS- *Rain water harvesting, Runoff, Mass flow curve, Demand.*

I. INTRODUCTION

Rainfall is considered as a direct access to the waters in the Earth, which also serves as a non-uniform phenomenon [1]. Rainfall occurs for a defined spell becomes runoff immediately as it hits the ground. As rainfall varies randomly, management of water demands for domestic, industrial and agriculture purpose is crucial. Karnataka state, is not an exception, shows a differential rainfall profile over the season. Rainfall pours in the state for three seasons: pre-monsoon, south-west monsoon or called as Mungaru and north-east monsoon or also called as Hingaru. Mungaru brings more than about 75 % of rainfall and covers large area of the state, whereas Hingaru covers 20 % of the annual rainfall. The other facade of annual rainfall in the state being very wide spectrum of its depth values i.e. as high as 3000 to 8000 mm nearby the Western Ghats, and as low as 400 to 600 mm in Bellary and some parts of Tumkur. This differential pattern of rainfall over a water year has necessitated either to go with any storage structures to store water such as reservoirs, or to endorse RWH measures.

Studies have also shown the successful execution of RWH in urban, sub-urban areas with low to moderate rainfall, or the places having high intensity of rainfall ([1], [2]).Of the communications, [2] deals with the planning of RWH system for an engineering college at Mysore, having an annual rainfall of 800 mm. It was concluded from the aforesaid work that although demand for water could be met in dry seasons, storage space becomes a major constraint.

While places on the hill slope of the Western Ghats receive high amount of annual rainfall, of the order 4000 to 8000 mm, water demands of the monsoon can be fed by existing water sources. The RWH methods may concentrate on recharging groundwater during monsoon. In [3],

suggestions are pondered to store rain water, by contracting farm-ponds, considering various catchment characteristics in a high rain fed area for post-monsoon consumptive uses. Irrespective of the intensity of rainfall, storage of harvested rainfall becomes a prominent feature. The storage capacity of RWH varies according to the uses for which the RWH system is designed. That means, the decision on the way of storing water or, in other way- storage of water by recharging groundwater depends upon how the water is to be used ([4]). It is also true that during monsoon seasons the groundwater levels hit the ground level in the coastal districts of Karnataka ([5]), which could become an overambitious approach towards adopting storage method of RWH.

This study aims at investigating the hydrological feasibility of RWH system in a college campus. This work does not includes water quality studies of water from RWH system. In essence, the main objectives are: i) to analyze the daily rainfall depths and to obtain daily runoff volumes, ii) to estimate the capacity of storage structure based on water demands, and iii) to inquire about the feasibility of methods of RWH.

II. THE CAMPUS

Shree Dharmasthala Manjunatheshwara Institute of Technology (SDMIT) is situated in Ujire, a town in the foothills of the Western Ghats, Dakshina Kannada district, Karnataka. The campus is well equipped with all infrastructure facilities. The SDMIT campus comprises of several building units such as: the college, hostels, and staff quarters. Daily rainfall is recorded in Belthangadi which is 8 km far away from the campus. The normal rainfall at Ujire is around 4700 mm. The man administrative unit of the college rests in a relatively high altitude-ridge portion, where it separates two hydrological systems. Topography of the campus is represented through the contours, in Fig.2. Daily rainfall pattern shows that there exist approximately 120 to 130 rainy days within a year.

III. METHOD OF ESTIMATING ROOFTOP DISCHARGE

IS-15797:2008 recommends guidelines for rooftop rainwater harvesting technique. According to this, urban housing complexes, residential blocks and institutional buildings are some of the prioritized areas for rooftop rain water harvesting rather than the individual-remote houses. It is quite fascinating to understand the mechanism of harvesting rooftop rain water in high rainfall areas viz. areas near the foothills of the Western Ghats where the annual rainfall amounts to be more than 4000 mm. Detailed methodology has been represented in figure 2.

The volume of rooftop rainfall, which can be considered as a flow, is a product of surface area and the height of rainfall on the surface. In order to express the rainfall as a runoff some losses have to be accounted. IS-15797:2008 specifies the runoff coefficients of the order 0.8 to 0.95 [6]. These runoff coefficients convey the amount of rainfall which could be converted into runoff when it hits any surface. For this particular work of estimating storage capacity a value of 0.8 for the runoff coefficient is adopted. Daily rainfall values for 30 years ranging from 1975 to 2005 have taken for consideration and year with least annual rainfall is chosen as an extreme year and upon which further calculations are being made. Daily runoff values are estimated from daily rainfall as a surface phenomenon. Surface area, specifically the roof top area is delineated using Google Earth for the campus, sums to be around 18000 square meters.

Figure 3 shows the daily rainfall series for a year. This region receives rainfall for around 120 to 130 days per year. Daily runoff values are obtained by multiplying a coefficient to the daily rainfall values. These rooftop runoff values are further made use in determining maximum capacity of storage structures to be constructed. This is through by mass curve method. A mass curve is a plot of accumulated flow against time. Mass curve method is adopted in calculating the reservoir capacity for a constant or varied demand pattern. The same concept has been perceived for this calculation, where accumulated rooftop runoff has been plotted against the time.

Fig.1: The Campus

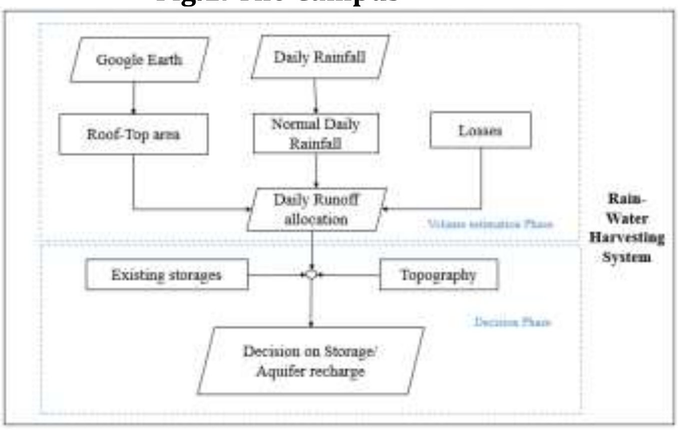

Fig. 2: Methodology of RWH storage assessment

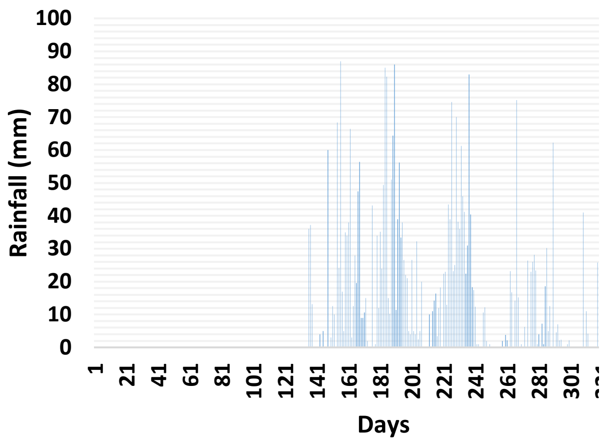

Fig. 3: Daily rainfall

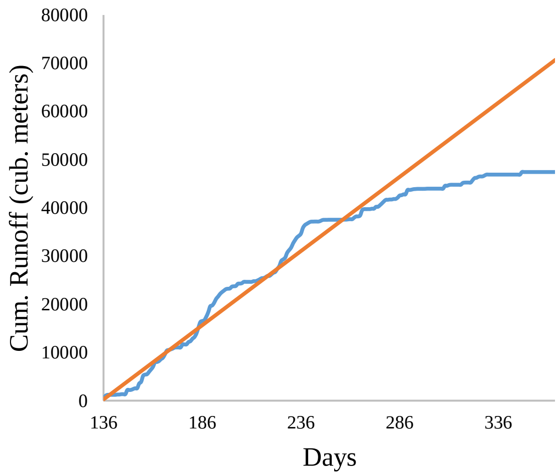

Fig. 4: Mass curve for constant daily water demand

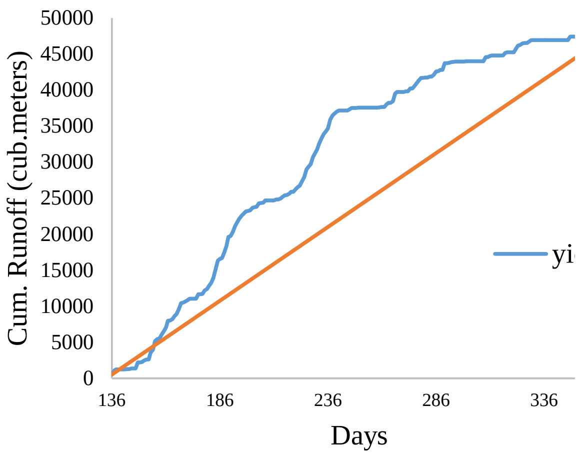

Fig. 5: Mass curve for demand equal to average yield throughout the year

Figure 4 highlights the yield pattern for constant daily demand of 150 lpcd. Demand tangent shows the surplus water availability in the months of June, July and August, whereas at end of September, October and other pre-monsoon months demand curve and the yield curves are diverging. This indicates the possibility of rooftop water storage in the monsoon months which can be fed for the later demands as well.

In Figure 5, the demand has been generalized from the yield pattern i.e., demand is obtained as an average yield throughout the year, indicated by the tangent drawn between two extreme end points. Using this method, a water demand which can be catered is around 204.9 cubic meters/day and the tank capacity is fixed for peak intercept drawn from tangent to the trough of the yield curve. The maximum intercept obtained from this method is 15196 cubic meters, which also serves to be a peak discharge. The dimensions of above said tank may amounts to be approximately 24 m X 24 m X 24 m, which is a vast facet to contrast.

IV. DISCUSSION

The study area falls in the windward side of the monsoon rainfall. This makes the area to receive large amount of rainfall in monsoon seasons. The rainfall of in-and-around the Western Ghats possesses unique characteristics, of which, most of the rainfall this area gets will be recorded within the short span of days. That is to say, maximum percentage of rainfall precipitates only for short time duration, for example 70 percent of the total annual rainfall will be fetched by 20 percent of days. Since, this short interval of time in terms of days are highly uncertain to gauge, there might exist a possibility of missing or omitting the maximum rainfall event. Perhaps, the intensity of rainfall over this area is also quite high and constructing a tank to catch the rooftop runoff, which is 80% of the rainfall, may become an over ambitious work and may run out of the economy too. For this huge amount of runoff, the number of poly-plastic tanks required are also high. Instead of supplying a whopping water solely from the rooftop water to all building units within the campus by catching the runoff in tanks, it can be sorted to supply water for any particular building block with highly intricate demand pattern, and remaining amount of runoff can be utilized for other purposes.

The terrain profile of the campus is highly uneven with the institute block standing at the peak and, hostel and other residential activities acquiring a lower elevation in the campus. It is also prominent to note that most of the bore wells, which are the sole source of water to the campus, are located in the low lands. This rugged profile of the terrain allows to think on the ground water recharge of excess rooftop water by choosing an appropriate method. Further investigations have to be made in selecting appropriate groundwater recharging techniques.

V. CONCLUSION

This study deals with the quantification of rooftop runoff and determining the capacity of rooftop water storage structure. It is evident from this study that scope of harvesting the rooftop water is supreme in monsoon months, and post monsoon months deviate from the demand line. Further, demand is fixed for an annual average yield of rooftop water and the probable capacity of the structure by considering the maximum discharge is gauged. This capacity is vast and subjected to the peculiarities of rainfall nearby the Western Ghats. It can be suggested to go for controlled use of rooftop water for storage purposes and the excess can be utilized in recharging the groundwater.

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